Mapping Sahelian Floodplain Vegetation from Satellite Imagery

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Introduction

The Logone floodplain in northern Cameroon floods annually, driving vegetation dynamics (Fig. 1). In the dry season, there is little above ground vegetation biomass, but in the wet season this can exceed 1200 g DM m^2 (Scholte 2005). Vegetation temporal and spatial dynamics are important to the migration patterns of pastoralists and their cattle. The aim of this project was to calculate the spatial distribution and quantify the area of dominant vegetation types.

Objectives

- Create vegetation maps of the ecosystem important perennial grass species (*Oryza longistaminata* and *Echinochloa pyramidalis*) for a subset of the floodplain
- Evaluate the accuracy between years to understand temporal model portability
- Estimate the area for the different vegetation types

Background

The extent of flooding and vegetation growth can be seen from remote sensing imagery (Fig. 1a). Overbank flooding begins upstream of Lake Maga and spreads up north to the El Beid. The dominant species were the perennials *O. longistaminata* and *E. pyramidalis* (Fig. 1b). Other types of vegetation include annuals (Fig. 1c), and ligneous plants (Fig. 1d).

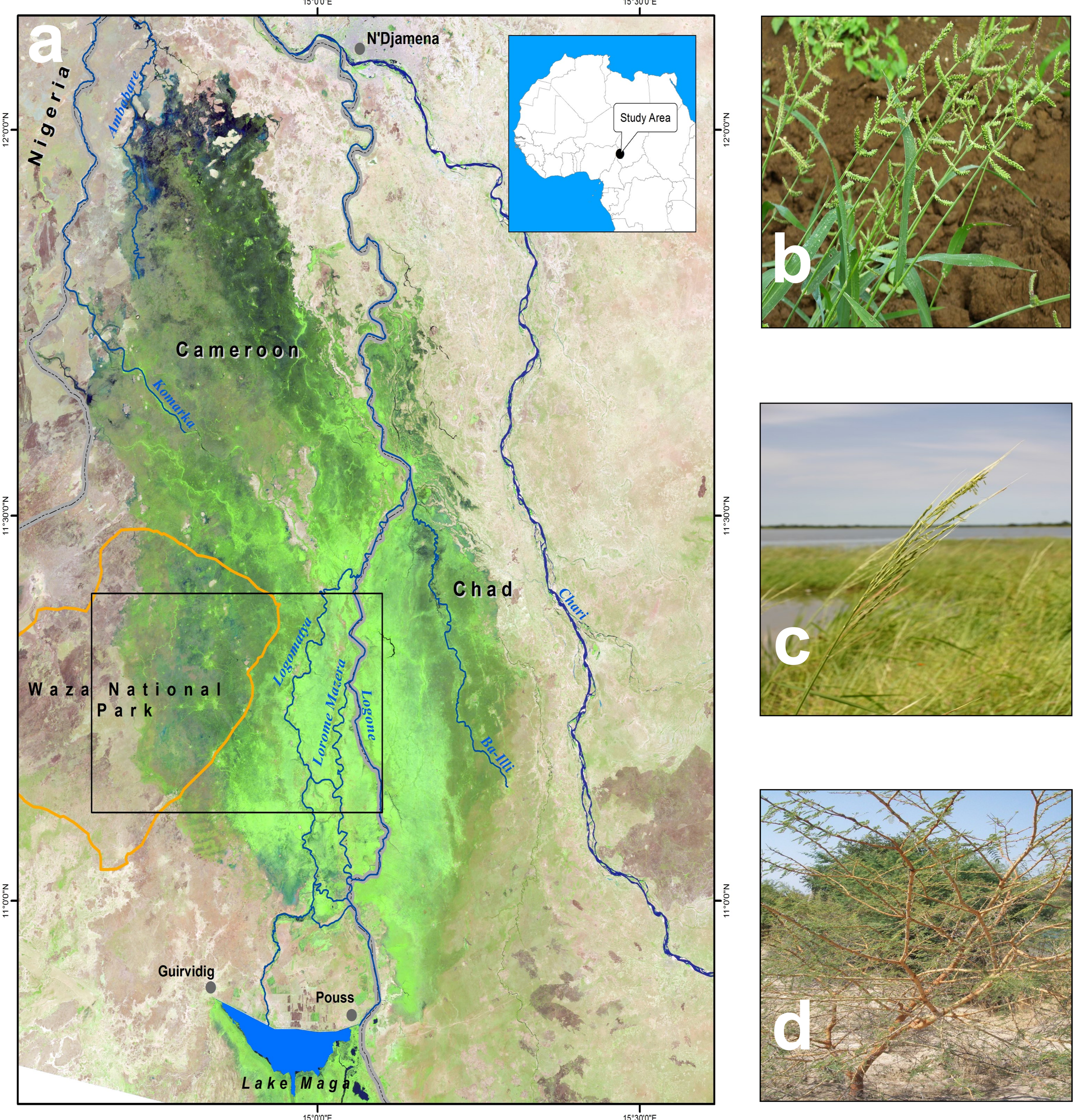

Fig 1. Landsat 8 image from 21 November 2015 and the different vegetation types present on the floodplain.

Methods

1. We classified sites of i) '*O. longistaminata* + *E. pyramidalis*'; ii) 'Other Vegetation'; iii) 'No Vegetation' (23 sites); iv) 'River' (28 sites); v) 'Settlements' (16 sites) on 17 October 2014 and 20 October 2015 Landsat imagery. Vegetation data was provided by Scholte, P. (GIZ Cameroon).

2. Classification was run on composite images from the Landsat 8 red, green, blue, and near-infrared bands using ENVI's maximum-likelihood.

3. We performed model validation using both 'leave-one-out cross-validation' (LOOCV) and splitting transect data into training and testing groups (Xie *et al.* 2008; Foody 2002). These groups were divided based on splitting the length of the transect into three sections (Fig. 5).

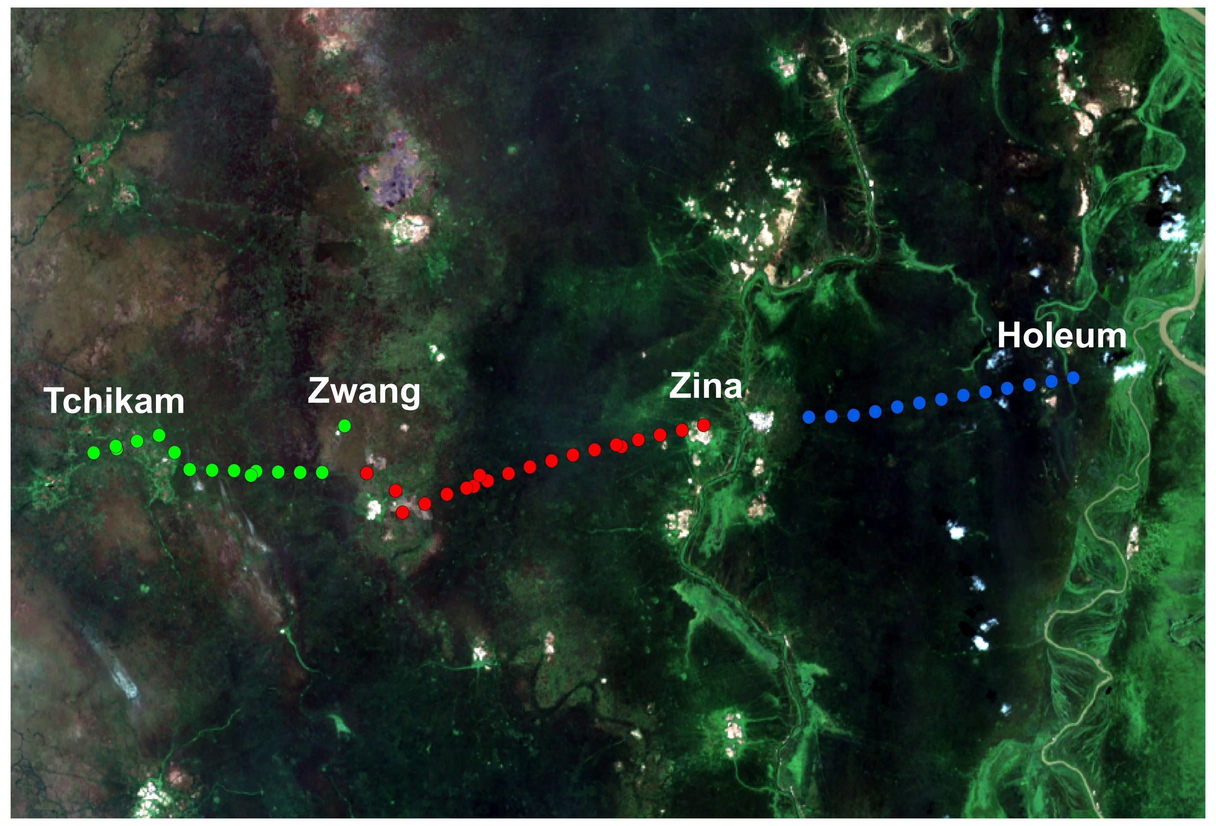

Fig. 5 Vegetation data was collected along a transect (n=48)

Results

- Models generated from all but one vegetation sites (LOOCV) were able to predict greater than 80% accuracy for both 2014 and 2015 (Fig. 6).
- Of the models generated from splitting the transect data, the 2014 ZT-ZH model was the most accurate with the highest Kappa Statistic (Table 1).
- The 2014 ZT-ZH model had high reliability for both '*O. longistaminata* + *E. pyramidalis'* and 'Other Vegetation', and had high accuracy for '*O. longistaminata* + *E. pyramidalis*', but not for 'Other Vegetation'. (Table 2).
- Applying the 2014 ZT-ZH model to our subset study site, the dominant class '*O. longistaminata* + *E. pyramidalis'* covered 381.06 km^2, while the 'Other Vegetation' class covered 345.60 km^2 (Fig. 7).

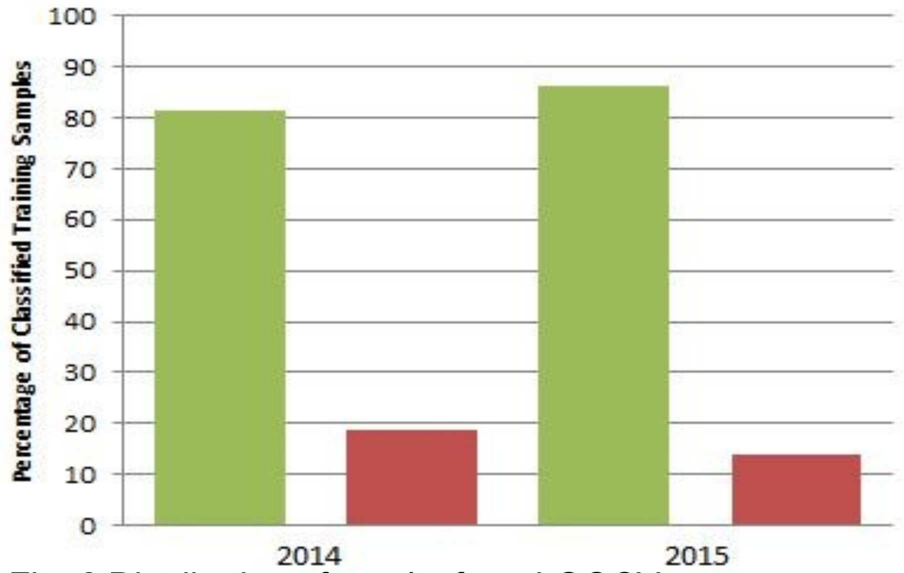

Fig. 6 Distribution of results from LOOCV

Table 1. Accuracy for split training models

Year	Transect Sites Used for Model Testing	Kappa Statistic
2014	Zina-Zwang	0.64
2014	Zina-Holeum	-0.41
2014	Zwang-Tchikam	-0.06
2015	Zina-Zwang	0.20
2015	Zina-Holeum	-0.12
2015	Zwang-Tchikam	-0.10

Table 2. Confusion matrix for Zwang-Tchikam and Zina-Holeum (2014)

Class	*O. longistaminata + E. pyramidalis*	OtherVeg	NoVeg	Accuracy
O. longistaminata + E. pyramidalis	12	0	0	1
OtherVeg	2	4	0	0.67
NoVeg	0	1	0	0
Reliability	0.86	0.8	0	

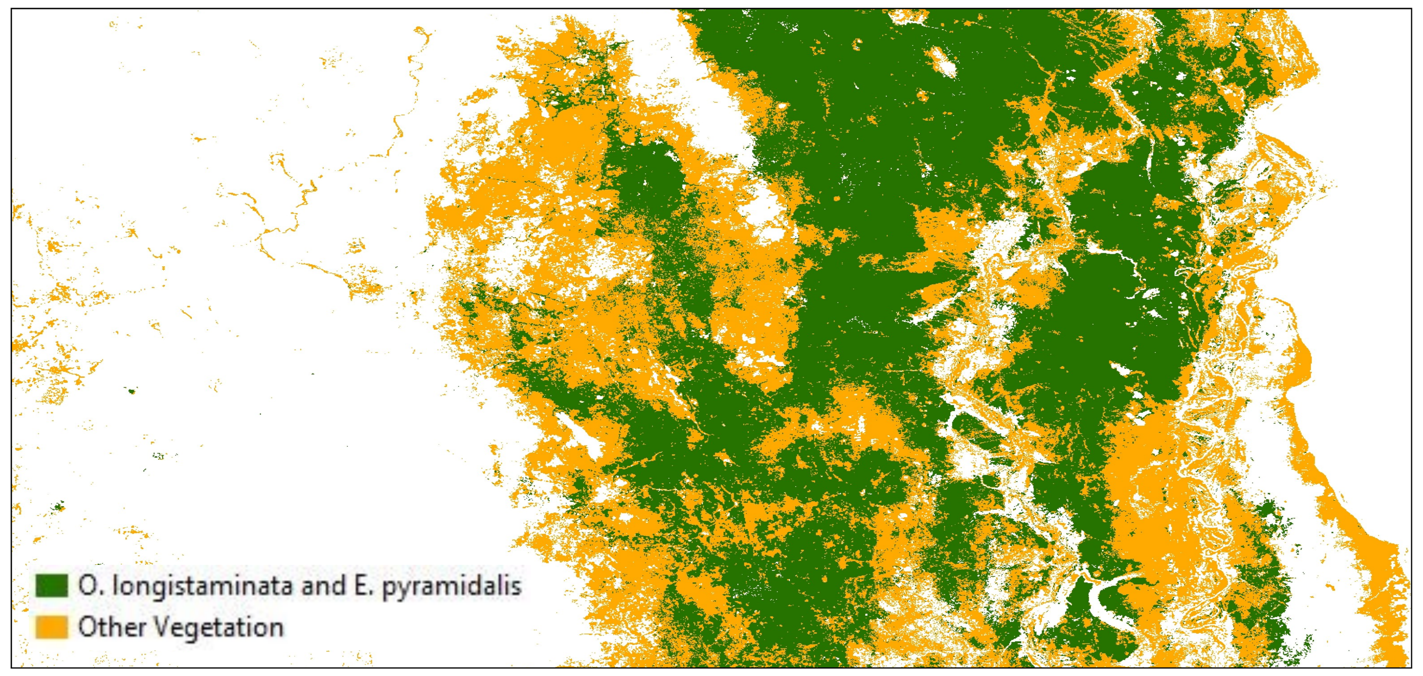

Fig. 7 Classification of Landsat 8 image, 17 October 2014, using transect data from the binned Zwang-Tchikam and Zina-Holeum sites.

Conclusion

- Logone floodplain vegetation classification maps can be produced using remote sensing imagery, but with varying accuracies.
- Models generated from using all the transect data (LOOCV) had high accuracy, but we could not account for spatial autocorrelation.
- The 2014 ZT-ZH split classification produced the most accurate map.
- The perennial class '*O. longistaminata* + *E. pyramidalis*' covered the greatest area on the subsection of the floodplain.
- The 'Other Vegetation' class covered a similar, but lesser, area.

Discussion

- Potential errors from classification include low variability between different grass species and differences between Landsat imagery resolution and the size of transect data survey plots.
- To further increase accuracy of classification, data can be collected randomly throughout the floodplain with larger plot sizes to closer match the resolution of Landsat imagery.
- Understanding the influence of the flooding variability between years and intra-year vegetation growth dynamics is needed to create a more robust model.
- Creating historic flood maps can be used to study the environmental impacts of flood management on the ecosystem and the people dependent on it.

References and Acknowledgments

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